

STABILIZING COMPOSITION FOR CHLORINE-CONTAINING POLYMERS

BACKGROUND OF THE INVENTION

1. Technical Field

The invention relates to stabilizer combinations which are free from metals, and
5 more particularly free from lead, barium and cadmium and are intended for stabilizing
chlorine-containing polymers, especially PVC.

2. Prior Art

PVC can be stabilized by a range of additives. Compounds of lead, of barium
and of cadmium are particularly suitable for this purpose and have been the main
10 stabilizer systems for many years on an industrial scale but are nowadays
controversial on ecological grounds because of their heavy metal content (cf. Kirk-
Othmer: "Encyclopedia of Chemical Technology", 4th ed., 1994, Vol. 12, Heat
Stabilizers, pp. 1071-1091). The search therefore continues for effective stabilizers
and stabilizer combinations which are free from lead, barium and cadmium.

15 1,3-disubstituted aminouracils have already been described as stabilizers for
chlorine-containing polymers and resins see for instance US 2,567,651 ;
US 6,174,941 B1 ; US 5,925,696 ; US 6,156,830 ; US 6,084,013 ; US 6,194,494 B1.

Other substances have been also described for the stabilization of chlorine-
containing polymers and resins :

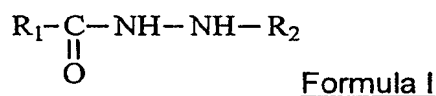
20 ➤ some of the latent-mercaptan-types are disclosed in EP 945,485 A1,
 ➤ N-alkyl maleimide-type substances in US 5,143,953,
 ➤ hydrazides of mono and dicarboxylic acids, preferably in combination
with a component having propylene oxide group(s), for improving the molding of PVC
pieces in FR 976.560 ; monoester-monohydrazides of dicarboxylic acids in
25 FR 1 533 020 ; N-acryloyl, N'-cyanoacetohydrazide and aromatic dihydrazides have
also been studied for the stabilisation of PVC resins (N.A.Mohamed, M.W.Sabaa,
Polymer International 45 (1998), 147-156) ; N.A.Mohamed, Polymer Degradation and
stability, 56 (1997), 317-329) ; JP 62-197,440 relates to the stabilisation of chlorine-
containing resin moulding by means of monohydrazide represented by the general
30 formula $RCONHNH_2$ wherein R is an alkyl (C_1 to C_{20}) or an aryl group. Some specific
hydrazides have been used as blowing agents in the manufacture of foamed plastics
articles: for instance sulfonic acid hydrazides in US 2,626,933 and aromatic sulfonyl
hydrazides and semicarbazides in US 4,164,611.

But the performances of stabilising compositions based on the above stabilisers free from metal-containing are weak and largely inferior to those based on metal-containing stabilisers, particularly when the temperatures and shear rate to process the chlorine-containing polymers are high, typically superior to 180 °C and/or in under high shear induced by process equipment.

SUMMARY OF THE INVENTION

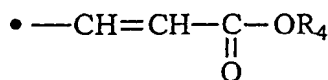
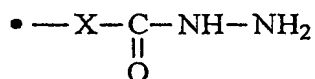
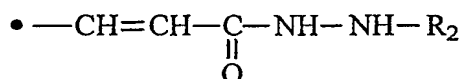
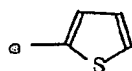
The present invention brings a new and efficient technical solution for stabilising chlorine-containing polymers and resins free from metals and environment-friendly. The invention relates to stabilizing compositions based on

- one or more hydrazides compounds having the following formula I:



where :

- R₁ is
- a C₁-C₃₀ alkyl group (linear or ramified), a C₂-C₃₀ alkyl group mono or polyunsaturated, C₁-C₃₀ alkyl group containing heteroatoms, C₁-C₃₀ alkyl group substituted by one or more phenyl groups (substituted or not), or by an epoxy function, or by a cycloaliphatic or heterocyclic group, or by halogen atom(s) or by a hydroxy or an alkoxy group.
 - a phenyl, benzyl, naphthyl, toluyl group, optionally substituted by -OH, -Cl, -alkoxy, -alkyl, - cycloalkyl, -COOR or OCOR (where R is a C₁-C₁₂ alkyl group)



R_3, R_4 is * a C_1 - C_{30} alkyl group (linear or ramified), a C_2 - C_{30} alkyl group mono or polyunsaturated, C_1 - C_{30} alkyl group containing heteroatoms, C_1 - C_{30} alkyl group substituted by one or more phenyl groups (substituted or not), or by an epoxy function, or by a cycloaliphatic or heterocyclic group, or by halogen atom(s) or by a hydroxy or an alkoxy group.

* a phenyl, naphthyl, phenyl group substituted by $-OH$, $-Cl$, alkoxy, alkyl, cycloalkyl, $-COOR$ or $OCOR$ (where R is a C_1 - C_{12} alkyl group)

X is *a C_1 - C_{30} alkylene group (linear or ramified), a C_2 - C_{30} alkylene group mono or polyunsaturated, C_1 - C_{30} alkylene group containing heteroatoms, C_1 - C_{30} alkylene group substituted by one or more phenylene groups (substituted or not), or by an epoxy function, or by a cycloaliphatic or heterocyclic group, or by halogen atom(s) or by a hydroxy or an alkoxy group.

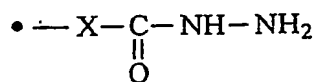
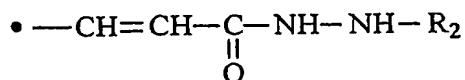
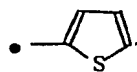
*a phenylene (in ortho, meta, para position), naphthylene, phenylene group substituted by $-OH$, $-Cl$, alkoxy, alkyl, cycloalkyl, $-COOR$ ou $OCOR$ (where R is a C_1 - C_{12} alkyl group)

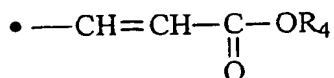
R_1 and R_2 can be linked by a covalent bond when $R_1 = -CH=CH-$ and $R_2 = -CO-$ (ketonic function) ;

the preferred hydrazides are those where :

R_1 is • a C_1 - C_{30} alkyl group (linear or ramified), a C_2 - C_{30} alkyl group mono or polyunsaturated, C_1 - C_{30} alkyl group containing heteroatoms, C_1 - C_{30} alkyl group substituted by one or more phenyl groups (substituted or not), or by an epoxy function, or by a cycloaliphatic or heterocyclic group, or by halogen atom(s) or by a hydroxy or an alkoxy group.

• a benzyl, naphthyl, toluyl group, optionally substituted by $-OH$, $-Cl$, - alkoxy, -alkyl, - cycloalkyl, $-COOR$ or $OCOR$ (where R is a C_1 - C_{12} alkyl group) or a phenyl group, optionally substituted by $-OH$, $-Cl$, -alkoxy, -alkyl, - cycloalkyl, or $OCOR$ (where R is a C_1 - C_{12} alkyl group)





5 R_3, R_4 is * a $\text{C}_1\text{--C}_{30}$ alkyl group (linear or ramified), a $\text{C}_2\text{--C}_{30}$ alkyl group mono or polyunsaturated, $\text{C}_1\text{--C}_{30}$ alkyl group containing heteroatoms, $\text{C}_1\text{--C}_{30}$ alkyl group substituted by one or more phenyl groups (substituted or not), or by an epoxy function, or by a cycloaliphatic or heterocyclic group, or by halogen atom(s) or by a hydroxy or an alkoxy group.

* a phenyl, naphthyl, phenyl group substituted by ---OH , ---Cl , alkoxy, alkyl, cycloalkyl, ---COOR or OCOR (where R is a $\text{C}_1\text{--C}_{12}$ alkyl group)

X is *a $\text{C}_1\text{--C}_{30}$ alkylene group (linear or ramified), a $\text{C}_2\text{--C}_{30}$ alkylene group mono or polyunsaturated, $\text{C}_1\text{--C}_{30}$ alkylene group containing heteroatoms, $\text{C}_1\text{--C}_{30}$ alkylene group substituted by one or more phenylene groups (substituted or not), or by an epoxy function, or by a cycloaliphatic or heterocyclic group, or by halogen atom(s) or by a hydroxy or an alkoxy group.

*a phenylene (in ortho, meta, para position), naphthylene, phenylene group substituted by ---OH , ---Cl , alkoxy, alkyl, cycloalkyl, ---COOR ou OCOR (where R is a $\text{C}_1\text{--C}_{12}$ alkyl group)

R_1 and R_2 can be linked by a covalent bond when $\text{R}_1 = \text{---CH=CH---}$ and $\text{R}_2 = \text{---CO---}$ (ketonic function)

□ and at least one of the following compound as co-stabiliser:

- one polyol and/or disaccharide alcohol,
- one perchlorate compound
- one glycidyl compound
- one layered lattice compound (hydrotalcite),
- one zeolite compound,
- one phosphite compound,
- one beta-diketone and/or beta ketoester,
- one mercaptocarboxylic ester,

- one metal soap,

the compositions containing both one hydrazide with $R_2=H$ and $R_1=$ phenylene substituted by COOR and one phosphite compound, which are disclosed in FR 1 533 020, should be excluded.

5 The most preferred hydrazides compositions are those for which at least one hydrazide is such as

R_1 is *a C_1-C_{17} alkyl group, e.g. methyl, butyl, octyl, ethyl-2-hexyl, stearyl, lauryl,

*X CO NHNH₂ where X is C_1-C_{17} alkylene group e.g. methylene, butylene, octylene, ethyl-2 hexylene, stearylene, dodecylene, or a 1,3- phenylene group

10 substituted or not

* a phenol substituted in ortho position, a benzenic cycle, an isophthalic group, a naphthol, a cyclo- S pentadiene-2,4, $C_6H_5-(CH_2)_n$ where $n=1$

R_2 is *H or COR₃ with R_3 is preferably chosen between C_1-C_{17} alkyl group, e.g. methyl, butyl, octyl, ethyle-2-hexyle, stearyl, lauryl, benzenic ring.

15 1-Polyols and Disaccharide Alcohols

Examples of suitable compounds of this type are: pentaerythritol, dipentaerythritol, tripentaerythritol, trimethylolethane, bistrimethylolpropane, inositol (cyclitols), polyvinyl alcohol, bis-trimethylolethane, trimethylolpropane, sorbitol (hexitols), maltitol, isomaltitol, cellobiitol, lactitol, lycasine, mannitol, lactose, leucrose, 20 tris(hydroxyethyl) isocyanurate, tris(hydroxypropyl) isocyanurate, palatinitol, tetramethylolcyclohexanol, tetramethylolcyclopentanol, tetramethylolcyclopyranol, xylitol, arabinitol (pentitols), tetritols, glycerol, diglycerol, polyglycerol, thiodiglycerol or 1-O-.alpha.-D-glycopyranosyl-D-mannitol dihydrate. Of these, preference is given to the disaccharide alcohols.

25 It is also possible to use polyol syrups, such as sorbitol, mannitol and maltitol syrup. The polyols and/or disaccharide compounds can be employed in an amount of, for example, from 0.01 to 20, judiciously from 0.1 to 20 and, in particular, from 0.1 to 10 parts by weight per 100 parts by weight of chlorine-containing polymers and resins, such as PVC.

30 2-Perchlorate Compounds

Examples are those of the formula $M(ClO_4)_n$, in which M is Li, Na, K, Mg, Ca, Sr, Ba, Zn, Al, La or Ce. Depending on the valency of M, the index n is 1, 2 or 3. The perchlorate salts can be present as solutions or can have been complexed with alcohols (polyols, cyclodextrins) or ether alcohols or ester alcohols. The ester

alcohols also include the polyol partial esters. In the case of polyhydric alcohols or polyols, their dimers, trimers, oligomers and polymers are also suitable, such as di-, tri-, tetra- and polyglycols and also di-, tri- and tetrapentaerythritol or polyvinyl alcohol in various degrees of polymerization. Other suitable solvents are phosphate esters and also cyclic and acyclic carbonates. In this context, the perchlorate salts can be employed in various common forms of presentation; for example, as a salt or solution in water or an organic solvent as such, or adsorbed on a support material such as PVC, Ca silicate, zeolites or hydrotalcites, or bound by chemical reaction into a hydrotalcite or into another layered lattice compound. As polyol partial ethers, preference is given to glycerol monoethers and glycerol monothioethers. Further embodiments are described in EP 0 394 547, EP 0 457 471 and WO 94/24200.

The perchlorates can be employed in an amount of, for example, from 0.001 to 5, judiciously from 0.01 to 3, and, with particular preference, from 0.01 to 2 parts by weight per 100 parts by weight of chlorine-containing polymers and resins, such as PVC.

3-Glycidyl Compounds

These contain the glycidyl group attached directly to carbon, oxygen, nitrogen

or sulfur atoms, such as in the present formula

$$\begin{array}{c} \text{---CH---(CH}_2\text{)}_n\text{---} \\ | \qquad \qquad \qquad | \quad | \quad | \\ \text{R}_1 \qquad \qquad \qquad \text{R}_2 \quad \text{R}_3 \end{array}$$

and in such compounds R_1 and R_3 are either both hydrogen and R_2 is hydrogen or methyl and n is 0 or R_1 and R_3 together are $\text{---CH}_2\text{---CH}_2\text{---}$ or $\text{---CH}_2\text{---CH}_2\text{---CH}_2\text{---}$ and in that case R_2 is hydrogen and n is 0 or 1.

I) Glycidyl esters and .beta.-methylglycidyl esters obtainable by reacting a compound having at least one carboxyl group in the molecule with epichlorohydrin or glyceroldichlorohydrin or .beta.-methylepichlorohydrin. The reaction takes place judiciously in the presence of bases.

As compounds having at least one carboxyl group in the molecule it is possible to use aliphatic carboxylic acids. Examples of these carboxylic acids are glutaric, adipic, pimelic, suberic, azelaic and sebacic acid or dimerized or trimerized linoleic acid, acrylic and methacrylic acid, caproic, caprylic, lauric, myristic, palmitic, stearic and pelargonic acid, and also the acids mentioned in connection with the organozinc compounds.

However, it is also possible to employ cycloaliphatic carboxylic acids, such as, for example, cyclohexanecarboxylic, tetrahydrophthalic, 4-methyltetrahydrophthalic, hexahydrophthalic or 4-methylhexahydrophthalic acid.

Aromatic carboxylic acids can also be used, examples being benzoic, phthalic, isophthalic, trimellitic and pyromellitic acid.

It is likewise possible to make use of carboxyl-terminated adducts of, for example, trimellitic acid with polyols, such as glycerol or 2,2-bis(4-hydroxycyclohexyl)propane. Other epoxide compounds which can be used in the context of this invention are given in EP 0 506 617.

10 II) Glycidyl ethers or .beta.-methylglycidyl ethers obtainable by reacting a compound having at least one free alcoholic hydroxyl group and/or phenolic hydroxyl group with an appropriately substituted epichlorohydrin under alkaline conditions or in the presence of an acidic catalyst with subsequent alkali treatment.

Ethers of this type are derived, for example, from acyclic alcohols, such as ethylene glycol, diethylene glycol and higher poly(oxyethylene) glycols, propane-1,2-diol, or poly(oxypropylene) glycols, propane-1,3-diol, butane-1,4-diol, poly(oxytetramethylene) glycols, pentane-1,5-diol, hexane-1,6-diol, hexane-2,4,6-triol, glycerol, 1,1,1-trimethylolpropane, bistrimethylolpropane, pentaerythritol, sorbitol, and from polyepichlorohydrins, butanol, amyl alcohol, pentanol, and from monofunctional alcohols such as isooctanol, 2-ethylhexanol, isodecanol and also C₇-C₉ -alkanol and C₉-C₁₁ -alkanol mixtures. They are also derived, however, for example, from cycloaliphatic alcohols, such as 1,3- or 1,4-dihydroxycyclohexane, bis(4-hydroxycyclohexyl)methane, 2,2-bis-(4-hydroxycyclohexyl)propane or 1,1-bis(hydroxymethyl)cyclohex-3-ene, or they possess aromatic nuclei, such as N,N-bis(2-hydroxyethyl)aniline or p,p'-bis(2-hydroxyethylamino)diphenylmethane.

25 The epoxide compounds can also be derived from mononuclear phenols, such as, for example, from phenol, resorcinol or hydroquinone; or, they are based on polynuclear phenols, such as, for example, on bis(4-hydroxyphenyl)methane, 2,2-bis(4-hydroxyphenyl)propane, 2,2-bis(3,5-dibromo-4-hydroxyphenyl)-propane, on 4,4'-dihydroxydiphenyl sulfone or on condensates of phenols with formaldehyde obtained under acidic conditions, such as phenol novolaks.

30 Examples of further possible terminal epoxides are: glycidyl 1-naphthyl ether, glycidyl 2-phenylphenyl ether, 2-biphenyl glycidyl ether, N-(2,3-epoxypropyl)phthalimide and 2,3-epoxypropyl 4-methoxyphenyl ether.

III) N-Glycidyl compounds obtainable by dehydrochlorination of the reaction products of epichlorohydrin with amines containing at least one amino hydrogen atom. These amines are, for example, aniline, N-methylaniline, toluidine, n-butylamine, bis(4-aminophenyl)methane, m-xylylenediamine or bis(4-methylaminophenyl)methane, and also N,N,O-triglycidyl-m-aminophenol or N,N,O-triglycidyl-p-aminophenol.

However, the N-glycidyl compounds also include N,N'-di, N,N',N''-tri- and N,N',N'',N'''-tetraglycidyl derivatives of cycloalkyleneureas, such as ethyleneurea or 1,3-propyleneurea and N,N'-diglycidyl derivatives of hydantoins, such as of 5,5-dimethylhydantoin or glycoluril and triglycidyl isocyanurate.

IV) S-Glycidyl compounds such as di-S-glycidyl derivatives derived from dithiols, such as ethane-1,2-dithiol or bis(4-mercaptomethylphenyl) ether, for example.

V) Epoxy compounds having a radical of the above formula in which R₁ and R₃ together are -CH₂-CH₂- and n is 0 are bis(2,3-epoxycyclopentyl) ether, 2,3-epoxycyclopentylglycidyl ether or 1,2-bis(2,3-epoxycyclopentyl)oxy ethane. An epoxy resin having a radical of the above formula in which R₁ and R₃ together are -CH₂-CH₂- and n is 1 is, for example, (3',4'-epoxy-6'-methylcyclohexyl)methyl 3,4-epoxy-6-methylcyclohexanecarboxylate.

Examples of suitable terminal epoxides are:

a) liquid bisphenol A diglycidyl ethers, such as Araldit® .GY 240, Araldit®.GY 250, Araldit®..GY 260, Araldit®.GY 266, Araldit® ..GY 2600, Araldit®..MY 790;

b) solid bisphenol A diglycidyl ethers, such as Araldit®..GT 6071, Araldit® GT 7071, Araldit®GT 7072, Araldit® .GT 6063, Araldit® GT 7203, Araldit® GT 6064, Araldit® GT 7304, Araldit®GT 7004, Araldit® GT 6084, Araldit® GT 1999, Araldit® GT 7077, Araldit® GT 6097, Araldit® GT 7097, Araldit® GT 7008, Araldit® GT 6099, Araldit® GT 6608, Araldit® GT 6609, Araldit® GT 6610;

c) liquid bisphenol F diglycidyl ethers, such as Araldit® .GY 281, Araldit® PY 302, Araldit® PY 306;

d) solid polyglycidyl ethers of tetraphenylethane, such as CG Epoxy Resin.0163;

e) solid and liquid polyglycidyl ethers of phenol-formaldehyde novolak, such as EPN 1138, EPN 1139, GY 1180, PY 307;

f) solid and liquid polyglycidyl ethers of o-cresol-formaldehyde novolak, such as ECN 1235, ECN 1273, ECN 1280, ECN 1299;

g) liquid glycidyl ethers of alcohols, such as Shell. Glycidyl ether 162, Araldit® DY 0390, Araldit®.DY 0391;

h) liquid glycidyl ethers of carboxylic acids, such as Shell®.Cardura E terephthalic acid ester, trimellitic acid ester, Araldit®.PY 284;

i) solid heterocyclic epoxy resins (triglycidyl isocyanurate), such as Araldit® PT 810;

j) liquid cycloaliphatic epoxy resins such as Araldit® CY 179;

k) liquid N,N,O-triglycidyl ethers of p-aminophenol, such as Araldit®MY 0510;

l) tetraglycidyl-4,4'-methylenebenzamine or N,N,N',N'-tetraglycidyldiaminophenylmethane, such as Araldit® MY 720, Araldit® MY 721.

Preference is given to the use of epoxy compounds having two functional groups. In principle, however, it is also possible to employ epoxy compounds having one, three or more functional groups.

Use is made predominantly of epoxy compounds, especially diglycidyl compounds, having aromatic groups.

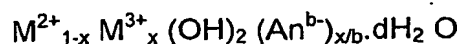
If desired, it is also possible to employ a mixture of different epoxy compounds. Particular preference is given as terminal epoxy compounds to diglycidyl ethers based on bisphenols, such as on 2,2-bis(4-hydroxyphenyl)propane (bisphenol A), bis(4-hydroxyphenyl)methane or mixtures of bis(ortho/para-hydroxyphenyl)methane (bisphenol F), for example.

The terminal epoxy compounds can be employed in an amount of preferably at least 0.1 part, for example from 0.1 to 50, judiciously from 1 to 30 and in particular, from 1 to 25 parts by weight, per 100 parts by weight of chlorine-containing polymers and resins, such as PVC.

4-Hydrotalcites

The chemical composition of these compounds is known to the person skilled in the art, for example, from patents DE 3,843,581, EP 0 062 813 and WO 93/20135.

Compounds from the series of the hydrotalcites can be described by the following general formula:



where

M^{2+} = one or more metals from the group Mg, Ca, Sr, Zn and Sn,

$M^{3+} = \text{Al or B,}$

An is an anion having the valency n,

b is a number from 1-2,

$0 < x < 0.5$

5 m is a number from 0-20 and d is a number in the range from 0 to 300, preferably in the range from 0.5 to 30..

Preferably An = OH^- , ClO_4^- , HCO_3^- , CH_3COO^- , $\text{C}_6\text{H}_5\text{COO}^-$, CO_3^{2-} , $(\text{CHOHCOO})_2^{2-}$, $(\text{CH}_2\text{COO})_2^{2-}$, $\text{CH}_3\text{CHOHCOO}^-$, HPO_3^- or HPO_4^{2-} ;

10 Examples of hydrotalcites are $\text{Al}_2\text{O}_3 \cdot 6\text{MgO} \cdot \text{CO}_2 \cdot 12\text{H}_2\text{O}$ (i), $\text{Mg}_{4.5}\text{Al}_2(\text{OH})_{13} \cdot \text{CO}_2 \cdot 3.5\text{H}_2\text{O}$ (ii), $4\text{MgO} \cdot \text{Al}_2\text{O}_3 \cdot \text{CO}_2 \cdot 9\text{H}_2\text{O}$ (iii), $4\text{MgO} \cdot \text{Al}_2\text{O}_3 \cdot \text{CO}_2 \cdot 6\text{H}_2\text{O}$, $\text{ZnO} \cdot 3\text{MgO} \cdot \text{Al}_2\text{O}_3 \cdot \text{CO}_2 \cdot 8-9\text{H}_2\text{O}$ and $\text{ZnO} \cdot 3\text{MgO} \cdot \text{Al}_2\text{O}_3 \cdot \text{CO}_2 \cdot 5-6\text{H}_2\text{O}$.

Very particular preference is given to types i, ii and iii.

5 Zeolites (Alkali Metal and Alkaline Earth Metal Aluminosilicates)

These can be described by the following general formula

15 $M_{x/n} [(\text{AlO}_2)_x (\text{SiO}_2)_y] \cdot w\text{H}_2\text{O}$

in which n is the charge of the cation M;

M is an element from the first or second main group, such as Li, Na, K, Mg, Ca, Sr or Ba;

y:x is a number from 0.8 to 15, preferably from 0.8 to 1.2; and

20 w is a number from 0 to 300, preferably from 0.5 to 30,

Examples of zeolites are sodium aluminosilicates of the following types: zeolite A, sodalite, zeolite Y, zeolite X;

or the zeolites preparable by complete or partial replacement of the Na atoms by Li, K, Mg, Ca, Sr or Zn atoms

25 Preferred zeolites are zeolite A, sodalite; zeolite Y, zeolite X; and those X zeolites having an Si/Al ratio of about 1:1 called LSX for Low Silica X, or the zeolites preparable by complete or partial replacement of the Na atoms by Li, K, Mg, Ca, Sr, Ba or Zn atoms.

The zeolites indicated can also be lower in water content, or anhydrous.

30 Further suitable zeolites are zeolite P zeolite MAP or the zeolites preparable by complete or partial replacement of the Na atoms by Li, K and/or H atoms, such as (, zeolite K-F, zeolite D , as described for instance in Barrer et al., J. Chem. Soc. 1952, 1561-71, and in U.S. Pat. No. 2,950,952;

Also suitable are the following zeolites: K offretite,; zeolite R,; zeolite LZ-217,; Ca-free zeolite LZ-218,; zeolite T, zeolite LZ-220, zeolite L; zeolite LZ-211; zeolite LZ-212; zeolite O, zeolite LZ-217; zeolite LZ-219; zeolite Rho, zeolite LZ-214,; zeolite ZK-19,; zeolite W (K-M), zeolite ZK-5; zeolite Q.

5 Particular preference is given to zeolite P grades of the above formula in which x is from 2 to 5 and y is from 3.5 to 10, and very particular preference is given to zeolite MAP of the standard formula in which x is 2 and y is from 3.5 to 10. In particular, the zeolite concerned is zeolite Na-P, i.e. M is Na. This zeolite generally occurs in the variants Na-P-1, Na-P-2 and Na-P-3, which differ in their cubic,
10 tetragonal or orthorhombic structure (R. M. Barrer, B. M. Munday, J. Chem. Soc. A 1971, 2909-14) The literature reference just referred to also describes the preparation of zeolite P-1 and P-2. According to that reference, Zeolite P-3 is very rare and is therefore of virtually no practical interest. The structure of the zeolite P-1 corresponds to the gismondite structure known from the abovementioned Atlas of
15 Zeolite Structures. In recent literature (EP-A-384 070) a distinction is made between cubic (zeolite B or Pc) and tetragonal (zeolite P1) zeolites of the P type. Also mentioned therein are relatively new zeolites of the P type having Si/Al ratios below 1.07:1. These are zeolites having the designation MAP or MA-P, for "Maximum Aluminum P".

20 Depending on the preparation process, zeolite P may also include small fractions of other zeolites. Highly pure zeolite P has been described in WO 94/26662. Within the scope of the invention it is also possible to use those finely divided, water-insoluble sodium aluminosilicates which have been precipitated and crystallized in the presence of water-soluble organic or inorganic dispersants. These can be
25 introduced into the reaction mixture in any desired manner, prior to or during the precipitation and crystallization.

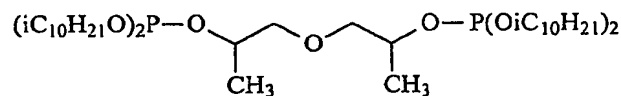
Very particular preference is given to Na zeolite A and Na zeolite P.

The hydrotalcites and/or zeolites can be employed in amounts, for example, from 0.1 to 20, judiciously from 0.1 to 10 and, in particular, from 0.1 to 5 parts by
30 weight per 100 parts by weight of chlorine-containing polymers and resins, such as PVC.

6-Phosphites (phosphorous trimesters), thiophosphites and thiophosphates

Examples are triphenyl phosphite, diphenyl alkyl phosphites, phenyl dialkyl phosphites, tris(nonylphenyl) phosphite, trilauryl phosphite, trioctadecyl phosphite,

distearyl pentaerythritol diphosphite, tris(2,4-di-tert-butylphenyl) phosphite, diisodecyl pentaerythritol diphosphite, bis(2,4-di-tert-butylphenyl) pentaerythritol diphosphite, bis(2,6-di-tert-butyl-4-methylphenyl) pentaerythritol diphosphite, bisisodecyloxy-pentaerythritol diphosphite, bis(2,4-di-tert-butyl-6-methylphenyl) pentaerythritol diphosphite, bis(2,4,6-tri-tert-butylphenyl) pentaerythritol diphosphite, tristearyl sorbitol triphosphite, bis(2,4-di-tert-butyl-6-methylphenyl) methylphenyl) methyl phosphite, bis(2,4-di-tert-butyl-6-methylphenyl) ethyl phosphite. Particularly suitable are trioctyl, tridecyl, tridodecyl, tritetradecyl, tristearyl, trioleyl, triphenyl, tricresyl, tris-p-nonylphenyl or tricylcohexyl phosphite and, with particular preference, the aryl dialkyl and alkyl diaryl phosphites, examples being phenyl didecyl, 2,4-di-tert-butylphenyl didodecyl phosphite, 2,6-di-tert-butylphenyl didodecyl phosphite and the dialkyl and diaryl pentaerythritol diphosphites, such as distearyl pentaerythritol diphosphite, and also nonstoichiometric triaryl phosphites whose composition is, for example, $(H_{19} C_9 - C_6 H_4)O_{1.5} P(OC_{12,13} H_{25,27})_{1.5}$ or $(H_8 C_{17} - C_6 H_4)O_2 P(i-C_8 H_{17} O)$ or



15 $(H_{19} C_9 - C_6 H_4)O_{1.5} P(OC_{9,11} H_{19,23})_{1.5}$ or

Preferred organic phosphites are distearyl pentaerythritol diphosphite, trisnonylphenyl phosphite and phenyl didecyl phosphite. Other suitable phosphites are phosphorous diesters (with abovementioned radicals) and phosphorous monoesters (with abovementioned radicals), possibly in the form of their alkali metal, alkaline earth metal, zinc or aluminum salts. It is also possible for these phosphorous esters to have been applied to an alumo salt compound; in this regard see also DE A-4 031 818.

The organic phosphites can be employed in an amount of, for example, from 0.01 to 10, judiciously from 0.05 to 5 and, in particular, from 0.1 to 3 parts by weight per 100 parts by weight of chlorine-containing polymers and resins, such as PVC.

By thiophosphites and thiophosphates are meant compounds of the general type (RS_3P) , $(RS_3P=O)$ and $(RS)_3P=S$, respectively, as are described, for instance, in the patents DE 2 809 492, EP 0 090 770 and EP 0 573 394. Examples of these compounds are trithiohexyl phosphite, trithiooctyl phosphite, trithiolauryl phosphite, trithiobenzyl phosphite, trithiophosphorous acid tris(carbo-i-octyloxy)methyl ester, trithiophosphorous acid tris(carbotrimethylcyclohexyloxy)methyl ester, trithiophosphoric acid S,S,S-tris(carbo-i-octyloxy)methyl ester, trithiophosphoric acid

S,S,S-tris(carbo-2-ethylhexyloxy)methyl ester, trithiophosphoric acid S,S,S-tris-1-(carbohexyloxy)ethyl ester, trithiophosphoric acid S,S,S-tris-1-(carbo-2-ethylhexyloxy)ethyl ester and trithiophosphoric acid S,S,S-tris-2-(carbo-2-ethylhexyloxy)ethyl ester.

5 7-Beta-diketones, beta-keto esters

1,3-dicarbonyl compounds which can be used may be linear or cyclic dicarbonyl compounds. Preference is given to the use of dicarbonyl compounds of the following formulae: $R'_1COCHR'_2-COR'_3$ in which R'_1 is C_1-C_{22} -alkyl, C_5-C_{10} -hydroxyalkyl, C_2-C_{18} -alkenyl, phenyl, OH-, C_1-C_4 -alkyl-, C_1-C_4 -alkoxy- or halogen-substituted phenyl, C_7-C_{10} -phenylalkyl, C_5-C_{12} -cycloalkyl, C_1-C_4 -alkyl-substituted C_5-C_{12} -cycloalkyl or a group $-R'_5-S-R'_6$ or $-R'_5-O-R'_6$, R'_2 is hydrogen, C_1-C_8 -alkyl, C_2-C_{12} -alkenyl, phenyl, C_7-C_{12} -alkylphenyl, C_7-C_{10} -phenylalkyl or a group $-CO-R'_4$, R'_3 is as defined for R'_1 or is C_1-C_{18} -alkoxy, R'_4 is C_1-C_4 -alkyl or phenyl, R'_5 is C_1-C_{10} -alkylene and R'_6 is C_1-C_{12} -alkyl, phenyl, C_7-C_{18} -alkylphenyl or C_7-C_{10} -phenylalkyl.

15 These include the hydroxyl-containing diketones of EP 0 346 279 and the oxa and thia diketones of EP 0 307 358, as well as the keto esters based on isocyanic acid, of US 4,339,383.

R'_1 and R'_3 as alkyl can in particular be C_1-C_{18} -alkyl, such as, for example methyl, ethyl, n-propyl, isopropyl, n-butyl, tert-butyl, pentyl, hexyl, heptyl, octyl, decyl, 20 dodecyl or octadecyl.

R'_1 and R'_3 as hydroxyalkyl are in particular a group $-(CH_2)_n-OH$ in which n is 5, 6 or 7.

R'_1 and R'_3 as alkenyl can for example be vinyl, allyl, methallyl, 1-butenyl, 1-hexenyl or oleyl, preferably allyl.

25 R'_1 and R'_3 as OH-, alkyl-, alkoxy- or halogen-substituted phenyl can for example be tolyl, xylyl, tert-butylphenyl, methoxyphenyl, ethoxyphenyl, hydroxyphenyl, chlorophenyl or dichlorophenyl.

R'_1 and R'_3 as phenylalkyl are in particular benzyl. R'_2 and R'_3 as cycloalkyl or alkylcycloalkyl are, in particular, cyclohexyl or methylcyclohexyl. R'_2 as alkyl can in 30 particular be C_1-C_4 -alkyl. R'_2 as C_2-C_{12} -alkenyl can in particular be allyl. R'_2 as alkylphenyl can in particular be tolyl. R'_2 as phenylalkyl can in particular be benzyl. Preferably, R'_2 is hydrogen. R'_3 as alkoxy can for example be methoxy, ethoxy, butoxy, hexyloxy, octyloxy, dodecyloxy, tridecyloxy, tetradecyloxy or octadecyloxy. R'_5 as C_1-C_{10} -alkylene is, in particular, C_2-C_4 -alkylene. R'_6 as alkyl is, in particular,

C₄-C₁₂ -alkyl, such as, for example butyl, hexyl, octyl, decyl or dodecyl. R'⁶ as alkylphenyl is in particular tolyl. R'⁶ as phenylalkyl is in particular benzyl. Examples of 1,3-dicarbonyl compounds of the above formula and their alkali metal, alkaline earth metal and zinc chelates are acetylacetone, butanoylacetone, heptanoylacetone, steroylacetone, palmitoylacetone, lauroylacetone, 7-tert-nonylthio-2,4-heptanedione, benzoylacetone, dibenzoylmethane, lauroylbenzoylmethane, palmitoylbenzoylmethane, stearylbenzoylmethane, isooctylbenzoylmethane, 5-hydroxycapronyl-benzoylmethane, tribenzoylmethane, bis(4-methylbenzoyl)methane, benzoyl-p-chlorobenzoylmethane, bis(2-hydroxybenzoyl)methane, 4-methoxybenzoyl-benzoylmethane, bis(4-methoxybenzoyl)methane, 1-benzoyl-1-acetylnonane, benzoylacetylphenylmethane, stearyl-4-methoxybenzoylmethane, bis(4-tert-butylbenzoyl)methane, benzoylformylmethane, benzoylphenylacetylmethane, biscyclohexanoylmethane, di-pivaloylmethane, 2-acetylcyclopentanone, 2-benzoylcyclopentanone, methyl, ethyl and allyl diacetoacetate, methyl and ethyl benzoyl-, propionyl- and butyrylacetoacetate, triacetylmethane, methyl, ethyl, hexyl, octyl, dodecyl or octadecyl acetoacetate, methyl, ethyl, butyl, 2-ethylhexyl, dodecyl or octadecyl benzoylacetate, and also C₁-C₁₈ -alkyl propionylacetates and butyrylacetates; ethyl, propyl, butyl, hexyl or octyl stearylacetate, and also polycyclic .beta.-keto esters, as described in EP 0 433 230, and dehydraacetic acid, and the zinc, magnesium or alkali metal salts thereof.

Preference is given to 1,3-diketo compounds of the above formula in which R'¹ is C₁-C₁₈ -alkyl, phenyl, OH-, methyl- or methoxy-substituted phenyl, C₇-C₁₀ -phenylalkyl or cyclohexyl, R'² is hydrogen and R'³ is as defined for R'¹. The 1,3-diketo compounds can be employed in amount of, for example, from 0.01 to 10, judiciously from 0.01 to 3 and, in particular, from 0.01 to 2 parts by weight per 100 parts by weight of chlorine-containing polymers and resins, such as PVC.

8-Mercaptocarboxylic esters

Examples of these compounds are esters of thioglycolic acid, thiomalic acid, mercaptopropionic acid, the mercaptobenzoic acids and thiolactic acid, mercaptoethyl stearate and mercaptoethyl oleate, as are described in patents FR 2459 816, EP 0 090 748, FR 2 552 440 and EP 0 365 483. The generic mercaptocarboxylic esters also embrace polyol esters and partial esters thereof, and also thioethers derived from them. These molecules may also be latent-mercaptides as described in EP -A1- 945 485

9- Metal soaps

Metal soaps are primarily metal carboxylates of preferably relatively long-chain carboxylic acids. Familiar examples are stearates and laurates, and also oleates and salts of shorter-chain alkanecarboxylic acids. Alkylbenzoic acids are also said to be included under metal soaps. Metals which may be mentioned are Li, Na, K, Mg, Ca, Sr, Ba, Zn, Al, La, Ce and rare earth metals. Use is often made of what are known as synergistic mixtures, such as barium/zinc, magnesium/zinc, calcium/zinc or calcium/magnesium/zinc stabilizers. The metal soaps can be employed individually or in mixtures. A review of common metal soaps is given in Ullmann's Encyclopedia of Industrial Chemistry, 5th Ed., Vol. A16 (1985), p. 361 ff.). It is judicious to use organic metal soaps from the series of the aliphatic saturated C₂-C₂₂ carboxylates, the aliphatic unsaturated C₃-C₂₂ carboxylates, the aliphatic C₂-C₂₂ carboxylates substituted by at least one OH group, the cyclic and bicyclic carboxylates having 5-22 carbon atoms, the unsubstituted benzenecarboxylates substituted by at least one OH group and/or by C₁-C₁₆ -alkyl, the unsubstituted naphthalenecarboxylates substituted by at least one OH group and/or by C₁-C₁₆ -alkyl, the phenyl C₁-C₁₆ -alkylcarboxylates, the naphthyl C₁-C₁₆ -alkylcarboxylates or the unsubstituted or C₁-C₁₂ -alkyl-substituted phenolates, tallates and resinates.

Named examples which may be mentioned are the zinc, calcium, magnesium or barium salts of monovalent carboxylic acids such as acetic, propionic, butyric, valeric, hexanoic, enanthoic, octanoic, neodecanoic, 2-ethylhexanoic, pelargonic, decanoic, undecanoic, dodecanoic, tridecanoic, myristic, palmitic, isostearic, stearic, 12-hydroxystearic, behenic, benzoic, p-tert-butylbenzoic, N,N-dimethylhydroxybenzoic, 3,5-di-tert-butyl-4-hydroxybenzoic, toluic, dimethylbenzoic, ethylbenzoic, n-propylbenzoic, salicylic, p-tert-octylsalicylic and sorbic acid; calcium, magnesium and zinc salts of the monoesters of divalent carboxylic acids such as oxalic, malonic, succinic, glutaric, adipic, fumaric, pentane-1,5-dicarboxylic, hexane-1,6-dicarboxylic, heptane-1,7-dicarboxylic, octane-1,8-dicarboxylic, phthalic, isophthalic, terephthalic and hydroxyphthalic acid; and of the di- or triesters of tri- or tetravalent carboxylic acids such as hemimellitic, trimellitic, pyromellitic and citric acid.

Preference is given to calcium, magnesium and zinc carboxylates of carboxylic acids having 7 to 18 carbon atoms (metal soaps in the narrow sense), such as, for example, benzoates or alkanoates, preferably stearate, oleate, laurate,

palmitate, behenate, hydroxystearates, dihydroxystearates or 2-ethylhexanoate. Particular preference is given to stearate, oleate and p-tert-butylbenzoate. Overbased carboxylates, such as overbased zinc octoate, are also preferred. Preference is likewise given to overbased calcium soaps.

5 If desired, it is also possible to employ a mixture of carboxylates of different structures.

Preference is given to compositions, as described, comprising an organozoic and/or organocalcium compound.

10 In addition to the compounds mentioned, organoaluminum compounds are also suitable, as are compounds analogous to those mentioned above, especially aluminum tristearate, aluminum distearate and aluminum monostearate, and also aluminum acetate and basic derivatives derived therefrom.

Further information on the aluminum compounds which can be used and are preferred is given in US 4,060,512 and US 3,243,394.

15 Also suitable in addition to the compounds already mentioned are organic rare earth compounds, especially compounds analogous to those mentioned above. The term rare earth compound means especially compounds of the elements cerium, praseodymium, neodymium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium, lanthanum and yttrium, mixtures--
20 especially with cerium--being preferred. Further preferred rare earth compounds can be found in EP-A-0 108 023.

It is possible if desired to employ a mixture of zinc, alkali metal, alkaline earth metal, aluminum, cerium, lanthanum or lanthanoid compounds of different structure. It is also possible for organozinc, organoaluminum, organocerium, organo-alkali
25 metal, organo-alkaline earth metal, organolanthanum or organolanthanoid compounds to be coated on an alumo salt compound; in this regard see also DE-A-4,031,818.

The metal soaps and/or mixtures thereof can be employed in an amount of, for example, from 0.001 to 10 parts by weight, judiciously from 0.01 to 8 parts and, with
30 particular preference, from 0.05 to 5 parts by weight per 100 parts by weight of chlorine-containing polymers and resins, such as PVC. The same applies to the further metal stabilizers.10- Further metal stabilizers

Here, mention may be made of the organometallic stabilizers and in particular of the organotin stabilizers. These can be the carboxylates, maleates, mercaptides and sulfides, in particular.

Examples of suitable compounds are described in US 4,743,640, US 2,567,651, US 2,598,936, US 2,567,652, US 6,174,941B1, US 5,925,696, US 6,156,830, US 6,084,013, US 6,194 494B1, US 4,105,627, US 4,352,903, DE 2,427,853.

Further customary additives can also optionally be added to the compositions of the invention, such as other stabilizers, auxiliaries and processing aids, examples being alkali metal compounds and alkaline earth metal compounds, lubricants, plasticizers, pigments, fillers, epoxidized fatty acid esters, antioxidants, UV absorbers and light stabilizers, optical brighteners, impact modifiers and processing aids, gelling agents, antistats, biocides, metal passivators, flame retardants and blowing agents, antifog agents, compatibilizers and antiplateouts agents. (cf. "Handbook of PVC Formulating" by E. J. Wickson, John Wiley & Sons, New York 1993). Examples of such additives are as follows:

I. Fillers and reinforcing agents are, for example, calcium carbonate, dolomite, wollastonite, magnesium oxide, magnesium hydroxide, silicates, china clay, talc, glass fibers, glass beads, wood flour, mica, metal oxides, or metal hydroxides, carbon black, graphite, rock flour, heavy spar, glass fibers, talc, kaolin and chalk.. The fillers can be employed in an amount of for example, from 5 to 80, judiciously from 10 to 40 and, in particular, from 10 to 20 parts by weight per 100 parts by weight of chlorine-containing polymers and resins, such as PVC.

II. Alkali metal and alkaline earth metal compounds

By these are meant principally the carboxylates of the above-described metal soaps (see part 9-), but also corresponding oxides and/or hydroxides or carbonates. Also suitable are mixtures thereof with organic acids. Examples are LiOH, NaOH, KOH, CaO, Ca(OH)₂, MgO, Mg(OH)₂, Sr(OH)₂, Al(OH)₃, CaCO₃ (also basic carbonates, such as magnesia alba and hutite), and also Na and K salts of fatty acids. In the case of alkaline earth metal and Zn carboxylates it is also possible to employ their adducts with MO or M(OH)₂ (M=Ca, Mg, Sr or Zn), known as "overbased" compounds. In addition to the stabilizer combination of the invention it is preferred to employ alkali metal carboxylates, alkaline earth metal carboxylates and/or aluminum carboxylates.

III. Lubricants

Examples of lubricants are montan wax, fatty acid esters, PE waxes, amide waxes, chlorinated paraffins, glycerol esters or alkaline earth metal soaps. Lubricants which can be used are also described in "Kunststoffadditive", R. Gachter/H. Muller, 5 Carl Hanser Verlag, 3rd Ed., 1989, pages 478-488. Mention may also be made of fatty ketones (as described in DE 4 204 887) and of silicone-based lubricants (as described in EP 0 225 261) or combinations thereof, as set out in EP 259,783. Calcium stearate is preferred. The lubricants can also be applied to an alumo salt compound; in this regard see also DE-A-4 031 818.

IV. Plasticizers

Examples of suitable organic plasticizers are those from the following groups:

A) Phthalates: examples of such plasticizers are dimethyl, diethyl, dibutyl, dihexyl, di-2-ethylhexyl, di-n-octyl, diisooctyl, diisononyl, diisodecyl, diisotridecyl, dicyclohexyl, dimethylcyclohexyl, dimethylglycol, dibutylglycol, benzyl butyl and 15 diphenyl phthalates, and also mixtures of phthalates, such as C7 -C9 - and C9 -C11 - alkyl phthalates obtained from predominantly linear alcohols, C6 -C10 -n-alkyl phthalates and C8 -C10 -n-alkyl phthalates. Of these preference is given to dibutyl, dihexyl, di-2-ethylhexyl, di-n-octyl, diisooctyl, diisononyl, diisodecyl, diisotridecyl and benzyl butyl phthalate, and the stated mixtures of alkyl phthalates. Particular 20 preference is given to di-2-ethylhexyl, diisononyl and diisodecyl phthalate, which are also known by the common abbreviations DOP (dioctyl phthalate, di-2-ethylhexyl phthalate), DINP (diisononyl phthalate) and DIDP (diisodecyl phthalate).

B) Esters of aliphatic dicarboxylic acids, especially esters of adipic, azelaic and sebacic acid: examples of such plasticizers are di-2-ethylhexyl adipate, diisooctyl 25 adipate (mixture), diisononyl adipate (mixture), diisodecyl adipate (mixture), benzyl butyl adipate, benzyl octyl adipate, di-2-ethylhexyl azelate, di-2-ethylhexyl sebacate and diisodecyl sebacate (mixture). Di-2-ethylhexyl adipate and diisooctyl adipate are preferred.

C) Trimellitates, examples being tri-2-ethylhexyl trimellitate, triisodecyl 30 trimellitate (mixture), triisotridecyl trimellitate, triisooctyl trimellitate (mixture) and also tri-C₆-C₈ -alkyl, tri-C₆-C₁₀ -alkyl, tri-C₇-C₉ -alkyl- and tri-C₉-C₁₁ -alkyl trimellitates. The latter trimellitates are formed by esterification of trimellitic acid with the corresponding alkanol mixtures. Preferred trimellitates are tri-2-ethylhexyl trimellitate and the abovementioned trimellitates from alkanol mixtures. Customary abbreviations are

TOTM (trioctyl trimellitate, tri-2-ethylhexyl trimellitate), TIDTM (triisodecyl trimellitate) and TITDTM (triisotridecyl trimellitate).

D) Epoxy plasticizers: these are primarily epoxidized unsaturated fatty acids, such as epoxidized soybean oil.

5 E) Polymer plasticizers: a definition of these plasticizers and examples of them are given in "Kunststoffadditive", R. Gachter/H. Muller, Carl Hanser Verlag, 3rd ed., 1989, section 5.9.6, pages 412-415, and also in "PVC Technology", W. V. Titow, 4th ed., Elsevier Publ., 1984, pages 165-170. The most common starting materials for preparing the polyester plasticizers are dicarboxylic acids, such as adipic, phthalic,
10 azelaic and sebacic acids; diols, such as 1,2-propanediol, 1,3-butanediol, 1,4-butanediol, 1,6-hexanediol, neopentyl glycol and diethylene glycol.

F) Phosphoric esters: a definition of these esters is given in the abovementioned "Taschenbuch der Kunststoffadditive" section 5.9.5, pp. 408-412. Examples of such phosphoric esters are tributyl phosphate, tri-2-ethylbutyl
15 phosphate, tri-2-ethylhexyl phosphate, trichloroethyl phosphate, 2-ethylhexyl diphenyl phosphate, cresyl diphenyl phosphate; triphenyl phosphate, tricresyl phosphate and trixylenyl phosphate. Preference is given to tri-2-ethylhexyl phosphate and to ..Reofos® 50 and 95 (Ciba Spezialitatenchemie).

G) Chlorinated hydrocarbons (paraffins)

20 H) Hydrocarbons

I) Monoesters, e.g., butyl oleate, phenoxyethyl oleate, tetrahydrofurfuryl oleate and alkylsulfonic esters.

J) Glycol esters, e.g., diglycol benzoates.

Definitions and examples of plasticizers of groups G) to J) are given in the
25 following handbooks: "Kunststoffadditive", R. Gachter/H. Muller, Carl Hanser Verlag, 3rd ed., 1989, section 5.9.14.2, pp. 422-425, (group G), and section 5.9.14.1, p. 422, (group H). "PVC Technology", W. V. Titow, 4th ed., Elsevier Publishers, 1984, section 6.10.2, pages 171-173, (group G), section 6.10.5 page 174, (group H), section 6.10.3, page 173, (group I) and section 6.10.4, pages 173-174 (group J). It is
30 also possible to use mixtures of different plasticizers. The plasticizers can be employed in an amount of, for example, from 5 to 20 parts by weight, judiciously from 10 to 20 parts by weight, per 100 parts by weight of of chlorine-containing polymers and resins, such as PVC. Rigid or semirigid PVC contains preferably up to 10%, with particular preference up to 5% of plasticizer, or no plasticizer.

V. Pigments

Suitable substrates are known to the person skilled in the art. Examples of inorganic pigments are TiO_2 , zirconium oxide-based pigments, BaSO_4 , zinc oxide (zinc white) and lithopones (zinc sulfide/barium sulfate), carbon black, carbon black/titanium dioxide mixtures, iron oxide pigments, Sb_2O_3 , $(\text{Ti}, \text{Ba}, \text{Sb})\text{O}_2$, Cr_2O_3 , spinels, such as cobalt blue and cobalt green, $\text{Cd}(\text{S}, \text{Se})$, ultramarine blue. Organic pigments are, for example, azo pigments, phthalocyanine pigments, quinacridone pigments, perylene pigments, diketopyrrolopyrrole pigments and anthraquinone pigments. Preference is also given to TiO_2 in micronized form.

VI. Epoxidized fatty acid esters and other epoxy compounds

The stabilizer combination of the invention may additionally comprise preferably at least one epoxidized fatty acid ester. Particularly suitable such esters are those of fatty acids from natural sources (fatty acid glycerides), such as soybean oil or rapeseed oil. It is, however, also possible to employ synthetic products such as epoxidized butyl oleate. Epoxidized polybutadiene and polyisoprene can also be used, as they are or in partially hydroxylated form, or else homo- or copolymeric glycidyl acrylate and glycidyl methacrylate can be used. These epoxy compounds can also have been applied to an alumo salt compound; in this regard see also DE A-4,031,818.

VII. Antioxidants

Customary antioxidants can be used, alone or in combination. Examples of suitable such compounds are alkylated monophenols, for example, 2,6-di-tert-butyl-4-methylphenol, 2-tert-butyl-4,6-dimethylphenol, 2,6-di-tert-butyl-4-ethylphenol, 2,6-di-tert-butyl-4-n-butylphenol, 2,6-di-tert-butyl-4-iso-butylphenol, 2,6-di-cyclopentyl-4-methylphenol, 2-(alpha-methylcyclohexyl)-4,6-dimethylphenol, 2,6-di-octadecyl-4-methylphenol, 2,4,6-tricyclohexylphenol, 2,6-di-tert-butyl-4-methoxymethylphenol, 2,6-dinonyl-4-methylphenol, 2,4-dimethyl-6-(1'-methylundec-1'-yl)phenol, 2,4-dimethyl-6-(1'-methylheptadec-1'-yl)phenol, 2,4-dimethyl-6-(1'-methyltridec-1'-yl)phenol, octylphenol, nonylphenol, dodecylphenol and mixtures thereof.

Alkylthiomethylphenols, for example, 2,4-dioctylthiomethyl-6-tert-butylphenol, 2,4-dioctylthiomethyl-6-methylphenol, 2,4-dioctylthiomethyl-6-ethylphenol, 2,6-didodecylthiomethyl-4-nonylphenol.

Alkylated hydroquinones, for example, 2,6-di-tert-butyl-4-methoxyphenol, 2,5-di-tert-butylhydroquinone, 2,5-di-tert-amylhydroquinone, 2,6-diphenyl-4-

octadecyloxyphenol, 2,6-di-tert-butylhydroquinone, 2,5-di-tert-butyl-4-hydroxyanisole, 3,5-di-tert-butyl-4-hydroxyanisole, 3,5-di-tert-butyl-4-hydroxyphenyl stearate, bis(3,5-di-tert-butyl-4-hydroxyphenyl) adipate.

Hydroxylated thiodiphenyl ethers, for example, 2,2'-thiobis(6-tert-butyl-4-methylphenol), 2,2'-thiobis(4-octylphenol), 4,4'-thiobis(6-tert-butyl-3-methylphenol), 4,4'-thiobis(6-tert-butyl-2-methylphenol), 4,4'-thiobis-(3,6-di-sec-amylphenol)-4,4'-bis(2,6-dimethyl-4-hydroxyphenyl) disulfide.

Alkylidenebisphenols, for example, 2,2'-methylenebis(6-tert-butyl-4-methylphenol), 2,2'-methylenebis(6-tert-butyl-4-ethylphenol), 2,2'-methylenebis[4-methyl-6-(alpha-methylcyclohexyl)phenol], 2,2'-methylenebis(4-methyl-6-cyclohexylphenol), 2,2'-methylenebis(6-nonyl-4-methylphenol), 2,2'-methylenebis(4,6-di-tert-butylphenol), 2,2'-ethylidenebis(4,6-di-tert-butylphenol), 2,2'-ethylidenebis(6-tert-butyl-4-isobutylphenol), 2,2'-methylenebis[6-(alpha-methylbenzyl)-4-nonylphenol], 2,2'-methylenebis[6-(alpha,alpha-dimethylbenzyl)-4-nonylphenol], 4,4'-methylenebis(2,6-di-tert-butylphenol), 4,4'-methylenebis(6-tert-butyl-2-methylphenol), 1,1-bis(5-tert-butyl-4-hydroxy-2-methylphenyl)butane, 2,6-bis(3-tert-butyl-5-methyl-2-hydroxybenzyl)-4-methylphenol 1,1,3-tris(5-tert-butyl-4-hydroxy-2-methyl-phenyl)butane, 1,1-bis-(5-tert-butyl-4-hydroxy-2-methylphenyl)-3-n-dodecylmercaptobutane, ethylene glycol bis[3,3-bis-(3'-tert-butyl-4'-hydroxyphenyl)butyrate], bis(3-tert-butyl-4-hydroxy-5-methylphenyl)dicyclopentadiene, bis[2-(3'-tert-butyl-2'-hydroxy-5'-methylbenzyl)-6-tert-butyl-4-methylphenyl] terephthalate, 1,1-bis(3,5-dimethyl-2-hydroxyphenyl)butane, 2,2-bis(3,5-di-tert-butyl-4-hydroxyphenyl)propane, 2,2-bis(4-hydroxyphenyl)propane, 2,2-bis(5-tert-butyl-4-hydroxy-2-methylphenyl)-4-n-dodecylmercaptobutane, 1,1,5,5-tetra(5-tert-butyl-4-hydroxy-2-methylphenyl)pentane.

Benzyl compounds, for example, 3,5,3',5'-tetra-tert-butyl-4,4'-dihydroxy-dibenzyl ether, octadecyl, 4-hydroxy-3,5-dimethylbenzyl-mercaptoacetate, tris(3,5-di-tert-butyl-4-hydroxybenzyl)amine, bis(4-tert-butyl-3-hydroxy-2,6-dimethylbenzyl)dithioterephthalate, bis(3,5-di-tert-butyl-4-hydroxybenzyl) sulfide, isooctyl, 3,5-di-tert-butyl-4-hydroxybenzyl-mercaptoacetate.

Hydroxybenzylated malonates, for example, dioctadecyl 2,2-bis(3,5-di-tert-butyl-2-hydroxybenzyl)malonate, dioactadecyl 2-(3-tert-butyl-4-hydroxy-5-methylbenzyl)malonate, didodecyl mercaptoethyl-2,2-bis(3,5-di-tert-butyl-4-

hydroxybenzyl)malonate, di[4-(1,1,3,3-tetramethylbutyl)-phenyl] 2,2-bis(3,5-di-tert-butyl-4-hydroxybenzyl)malonate.

Aromatic hydroxybenzyl compounds, for example, 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl)-2,4,6-trimethylbenzene, 1,4-bis(3,5-di-tert-butyl-4-hydroxybenzyl)-2,3,5,6-tetramethylbenzene, 2,4,6-tris(3,5-di-tert-butyl-4-hydroxybenzyl)phenol.

Triazine compounds, for example, 2,4-bis(octylmercapto-6-(3,5-di-tert-butyl-4-hydroxyanilino)-1,3,5-triazine, 2-octylmercapto-4,6-bis-(3,5-di-tert-butyl-4-hydroxyanilino)-1,3,5-triazine, 2-octylmercapto-4,6-bis-(3,5-di-tert-butyl-4-hydroxyphenoxy)-1,3,5-triazine, 2,4,6-tris(3,5-di-tert-butyl-4-hydroxyphenoxy)-1,2,3-triazine, 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl)isocyanurate, 1,3,5-tris(4-tert-butyl-3-hydroxy-2,6-dimethylbenzyl) isocyanurate, 2,4,6-tris(3,5-di-tert-butyl-4-hydroxyphenylethyl)-1,3,5-triazine, 1,3,5-tris(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)hexahydro-1,3,5-triazine, 1,3,5-tris-(3,5-dicyclohexyl-4-hydroxybenzyl) isocyanurate.

Phosphates and phosphonites, for example, dimethyl 2,5-di-tert-butyl-4-hydroxybenzylphosphonate, diethyl 3,5-di-tert-butyl-4-hydroxybenzylphosphonate, dioctadecyl 3,5-di-tert-butyl-4-hydroxybenzylphosphonate, dioctadecyl 5-tert-butyl-4-hydroxy-3-methylbenzylphosphonate, Ca salt of monoethyl 3,5-di-tert-butyl-4-hydroxybenzylphosphonate, tetrakis(2,4-di-tert-butylphenyl)-4,4'-biphenylenediphosphonite, 6-isooctyloxy-2,4,8,10-tetra-tert-butyl-12H-dibenz[d,g]-1,3,2-dioxaphosphocine, 6-fluoro-2,4,8,10-tetra-tert-butyl-12-methyl-dibenz[d,g]-1,3,2-dioxaphosphocine.

Acylaminophenols, for example, 4-hydroxylauranilide, 4-hydroxystearanilide, octyl N-(3,5-di-tert-butyl-4-hydroxyphenyl)carbamate.

Esters of beta-(3,5-di-tert-butyl-4-hydroxyphenyl)propionic acid with mono- or polyhydric alcohols, e.g. with methanol, ethanol, octanol, octadecanol, 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propane diol, neopentyl glycol, thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol, dipentaerythritol, tris(hydroxyethyl) isocyanurate, N,N'-bis(hydroxyethyl)oxalamide, 3-thiaundecanol, 3-thiapentadecanol, trimethylhexanediol, trimethylolpropane, ditrimethylolpropane, 4-hydroxymethyl-1-phospha-2,6,7-trioxabicyclo[2.2.2]octane.

Esters of beta-(5-tert-butyl-4-hydroxy-3-methylphenyl)propionic acid with mono- or polyhydric alcohols, for example, with methanol, ethanol, octanol, octadecanol, 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol

neopentyl glycol, thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris(hydroxy)ethyl isocyanurate, N,N'-bis(hydroxyethyl)oxalamide, 3-thiaundecanol, 3-thiapentadecanol, trimethylhexanediol, trimethylolpropane, 4-hydroxymethyl-1-phospha-2,6,7-trioxabicyclo[2.2.2]octane.

5 Esters of beta-(3,5-dicyclohexyl-4-hydroxyphenyl)propionic acid with mono- or polyhydric alcohols, for example, with methanol, ethanol, octanol, octadecanol, 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris(hydroxy)ethyl isocyanurate, N,N'-bis(hydroxyethyl)oxalamide, 3-thiaundecanol, 3-
10 thiapentadecanol, trimethylhexanediol, trimethylolpropane, 4-hydroxymethyl-1-phospha-2,6,7-trioxabicyclo[2.2.2]octane.

 Esters of 3,5-di-tert-butyl-4-hydroxyphenylacetic acid with mono- or polyhydric alcohols, for example, with methanol, ethanol, octanol, octadecanol, 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodiethylene
15 glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris(hydroxy)ethyl isocyanurate, N,N'-bis(hydroxyethyl)oxalamide, 3-thiaundecanol, 3-thiapentadecanol, trimethylhexanediol, trimethylpropane, 4-hydroxymethyl-1-phospha-2,6,7-trioxabicyclo[2.2.2]octane.

 Amides of beta-(3,5-di-tert-butyl-4-hydroxyphenyl)propionic acid, such as, for
20 example, N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)hexamethylenediamine, N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)trimethylenediamine, N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)hydrazine.

 Vitamin E (tocopherol) and derivatives.

 Preference is given to antioxidants of groups 1-5, 10 and 12, especially 2,2-bis(4-hydroxyphenyl)propane, esters of 3,5-di-tert-butyl-4-hydroxyphenylpropionic
25 acid with octanol, octadecanol or pentaerythritol or tris(2,4-di-tert-butylphenyl) phosphite. It is also possible, if desired, to employ a mixture of antioxidants of different structures.

 The antioxidants can be employed in an amount of, for example, from 0.01 to
30 10 parts by weight judiciously from 0.1 to 10 parts by weight and in particular, from 0.1 to 5 parts by weight per 100 parts by weight of PVC.

 VIII. UV absorbers and light stabilizers

 Examples of these are:

2-(2'-Hydroxyphenyl)benzotriazoles, such as, for example 2-(2'-hydroxy-5'-methylphenyl)benzotriazole, 2-(3',5'-di-tert-butyl-2'-hydroxyphenyl)benzo-triazole, 2-(5'-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(2'-hydroxy-5'-(1,1,3,3-tetramethylbutyl)phenyl)benzotriazole, 2-(3',5'-di-tert-butyl-2'-hydroxyphenyl)-5-chlorobenzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-methylphenyl)-5-chlorobenzotriazole, 2-(3'-sec-butyl-5'-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(2'-hydroxy-4'-octoxyphenyl)benzotriazole, 2-(3',5'-di-tert-amyl-2'-hydroxyphenyl)benzotriazole, 2-(3',5'-bis(alpha,alpha-dimethylbenzyl)-2'-hydroxyphenyl)benzotriazole, mixtures of 2-(3'-tert-butyl-2'-hydroxy-5'-(2-octyloxycarbonylethyl)phenyl)-5-chlorobenzotriazole, 2-(3'-tert-butyl-5'-[2-(2-ethylhexyloxy)carbonylethyl]-2'-hydroxyphenyl)-5-chlorobenzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-methoxycarbonylethyl)phenyl)-5-chlorobenzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-methoxycarbonylethyl)phenyl)benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-octyloxycarbonylethyl)phenyl)benzotriazole, 2-(3'-tert-butyl-5'-[2-(2-ethylhexyloxy)carbonylethyl]-2'-hydroxyphenyl)benzotriazole, 2-(3'-dodecyl-2'-hydroxy-5'-methylphenyl)benzotriazole and 2-(3'-tert-butyl-2'-hydroxy-5'-(2-isooctyloxycarbonylethyl)phenyl)benzotriazole, 2,2'-methylenebis[4-(1,1,3,3-tetramethylbutyl)-6-benzotriazol-2-ylphenol]; the transesterification product of 2-[3'-tert-butyl-5'-(2-methoxycarbonylethyl)-2'-hydroxyphenyl]benzotriazole with polyethylene glycol 300; where R=3'-tert-butyl-4'-hydroxy-5'-2H-benzotriazol-2-ylphenyl.

2-Hydroxybenzophenones, for example the 4-hydroxy, 4-methoxy, 4-octoxy, 4-decyloxy, 4-dodecyloxy, 4-benzyloxy, 4,2',4'-trihydroxy, 2'-4,4'-dimethoxy derivative.

25 Esters of substituted or unsubstituted benzoic acids, for example 4-tert-butylphenyl salicylate, phenyl salicylate, octylphenyl salicylate, dibenzoylresorcinol, bis(4-tert-butylbenzoyl)resorcinol, benzoylresorcinol, 2,4-di-tert-butylphenyl 3,5-di-tert-butyl-4-hydroxybenzoate, hexadecyl 3,5-di-tert-butyl-4-hydroxybenzoate, octadecyl 3,5-di-tert-butyl-4-hydroxybenzoate, 2-methyl-4,6-di-tert-butylphenyl 3,5-di-tert-butyl-4-hydroxybenzoate.

30 Acrylates, for example ethyl alpha-cyano-beta,beta-diphenylacrylate or isooctyl-ethyl alpha-cyano-beta,beta-diphenylacrylate, methyl alpha-carbomethoxycinnamate, methyl alpha-cyano-beta-methyl-p-methoxycinnamate or butyl

alpha-cyano-beta-methyl-p-methoxycinnamate, methyl alpha-carbomethoxy-p-methoxycinnamate, N-(beta-carbomethoxy-b-cyanovinyl)-2-methyl-indoline.

Nickel compounds, for example nickel complexes of 2,2'-thiobis[4-(1,1,3,3-tetramethylbutyl)phenol], such as the 1:1 or 1:2 complex, with or without additional
 5 ligands such as n-butylamine, triethanolamine or N-cyclohexyldiethanolamine, nickel dibutyldithiocarbamate, nickel salts of monoalkyl esters such as the methyl or ethyl ester, of 4-hydroxy-3,5-di-tert-butylbenzylphosphonic acid, nickel complexes of ketoximes, such as of 2-hydroxy-4-methylphenyl undecyl ketoxime, nickel complexes of 1-phenyl-4-lauroyl-5-hydroxypyrazole, with or without additional ligands.

10 Oxalamides, for example 4,4'-dioctyloxyoxanilide, 2,2'-dioctyloxy-5,5'-di-tert-butyl-oxanilide, 2,2'-didodecyloxy-5,5'-di-tert-butyl-oxanilide, 2-ethoxy-2'-ethyl-oxanilide, N,N'-bis(3-dimethylaminopropyl)oxalamide, 2-ethoxy-5-tert-butyl-2'-ethyloxanilide and its mixture with 2-ethoxy-2'-ethyl-5,4'-di-tert-butyl-oxanilide, mixtures of o- and p-methoxy and of o- and p-ethoxy-di-substituted oxanilides.

15 2-(2-Hydroxyphenyl)-1,3,5-triazines, for example 2,4,6-tris(2-hydroxy-4-octyloxyphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-octyloxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2,4-dihydroxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2,4-bis(2-hydroxy-4-propyloxyphenyl)-6-(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-octyloxyphenyl)-4,6-bis(4-methylphenyl)-1,3,5-triazine, 2-(2-
 20 hydroxy-4-dodecyloxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-[2-hydroxy-4-(2-hydroxy-3-butyloxypropyloxy)phenyl]-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-[2-hydroxy-4-(2-hydroxy-3-octyloxypropyloxy)phenyl]-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine.

Sterically hindered amines, for example bis(2,2,6,6-tetramethyl-piperidin-4-yl)
 25 sebacate, bis(2,2,6,6-tetramethylpiperidin-4-yl) succinate, bis(1,2,2,6,6-pentamethylpiperidin-4-yl) sebacate, bis(1-octyloxy-2,2,6,6-tetramethylpiperidin-4-yl) sebacate, bis(1,2,2,6,6-pentamethylpiperidin-4-yl) n-butyl-3,5-di-tert-butyl-4-hydroxybenzylmalonate, the condensate of 1-hydroxyethyl-2,2,6,6-tetramethyl-4-hydroxypiperidine and succinic acid, linear or cyclic condensates of N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine and 4-tert-octylamino-2,6-dichloro-
 30 1,3,5-s-triazine, tris(2,2,6,6-tetramethyl-4-piperidyl) nitrilotriacetate, tetrakis(2,2,6,6-tetramethyl-4-piperidyl) 1,2,3,4-butanetetraoate, 1,1'-(1,2-ethanediyl)-bis(3,3,5,5-tetramethylpiperazinone), 4-benzoyl-2,2,6,6-tetramethylpiperidine, 4-stearyloxy-2,2,6,6-tetramethylpiperidine, bis(1,2,2,6,6-pentamethylpiperidyl) 2-n-butyl-2(2-

hydroxy-3,5-di-tert-butylbenzyl)malonate, 3-n-octyl-7,7,9,9-tetramethyl-1,3,8-triazaspiro[4.5]decane-2,4-dione, bis(1-octyloxy-2,2,6,6-tetramethylpiperidyl) sebacate, bis(1-octyloxy-2,2,6,6-tetramethylpiperidyl) succinate, linear or cyclic condensates of N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine and 4-morpholino-2,6-dichloro-1,3,5-triazine, the condensate of 2-chloro-4,6-di-(4-n-butylamino-2,2,6,6-tetramethylpiperidyl)-1,3,5-triazine and 1,2-bis(3-aminopropylamino)ethane, the condensate of 2-chloro-4,6-di(4-n-butylamino-1,2,2,6,6-pentamethylpiperidyl)-1,3,5-triazine and 1,2-bis(3-aminopropylamino)ethane, 8-acetyl-3-dodecyl-7,7,9,9-tetramethyl-1,3,8-triazaspiro[4.5]decane-2,4-dione, 3-dodecyl-1-(2,2,6,6-tetramethyl-4-piperidyl)pyrrolidone-2,5-dione, 3-dodecyl-1-(1,2,2,6,6-pentamethyl-4-piperidyl)pyrrolidine-2,5-dione, mixtures of 4-hexadecyloxy- and 4-stearyloxy-2,2,6,6-tetramethylpiperidine, the condensate of N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine and 4-cyclohexylamino-2,6-dichloro-1,3,5-triazine, the condensate of 1,2-bis(3-aminopropylamino)ethane and 2,4,6-trichloro-1,3,5-triazine, and also 4-butylamino-2,2,6,6-tetramethylpiperidine (CAS Reg. No. [136504-96-6]); N-(2,2,6,6-tetramethyl-4-piperidyl)-n-dodecylsuccinimide, N-(1,2,2,6,6-pentamethyl-4-piperidyl)-n-dodecylsuccinimide, 2-undecyl-7,7,9,9-tetramethyl-1-oxa-3,8-diaza-4-oxospiro[4.5]decane, the reaction product of 7,7,9,9-tetramethyl-2-cycloundecyl-1-oxa-3,8-diaza-4-oxospiro[4.5]decane and epichlorohydrin, 1,1-bis(1,2,2,6,6-pentamethyl-4-piperidyloxycarbonyl)-2-(4-methoxyphenyl)ethane, N,N'-bisformyl-N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine, the diester of 4-methoxymethylenemalonic acid with 1,2,2,6,6-pentamethyl-4-hydroxypiperidine, poly[methylpropyl-3-oxy-4-(2,2,6,6-tetramethyl-4-piperidyl)]-siloxane, the reaction product of maleic anhydride- α -olefin copolymer and 2,2,6,6-tetramethyl-4-aminopiperidine or 1,2,2,6,6-pentamethyl-4-aminopiperidine.

IX. Blowing agents

Examples of blowing agents are organic azo and hydrazo compounds, tetrazoles, oxazines, isatoic anhydride, and also sodium carbonate and sodium bicarbonate. Preference is given to azodicarboxamide and sodium bicarbonate and mixtures thereof.

X. Other additives

Definitions and examples of impact modifiers, thermal modifiers, processing aids, gelling agents, antistatic agents, biocides, fungicides, metal passivators, optical

brighteners, flame retardants, antifogging agents and compatibilizers are described in "Kunststoffadditive", R. Gachter/H. Muller, Carl Hanser Verlag, 3rd ed., 1989, and in the "Handbook of Polyvinyl Chloride Formulating" E. J. Wickson, J. Wiley & Sons, 1993, and in "Plastics Additives" G. Pritchard, Chapman & Hall, London, 1st ed., 1998. Impact modifiers are also described in detail in "Impact Modifiers for PVC", J. T. Lutz/D. L. Dunkelberger, John Wiley & Sons, 1992.

The compositions of the present invention can also contain other stabilisers such as aminouracils and particularly 6-aminouracils disclosed for instance in US 6,174,941 B1 and/or thiouracils and particularly 4-amino 6-hydroxy 2-mercapto-pyrimidine.

The invention also relates to a method of stabilizing chlorine-containing polymers, which comprises adding thereto at least one of the above stabilising combinations of the present invention. Stabilization means at least both UV and heat stabilization.

Examples of the chlorine-containing polymers to be stabilized are polymers of vinyl chloride and of vinylidene chloride, vinyl resins comprising vinyl chloride units in their structure, such as copolymers of vinyl chloride, and vinyl esters of aliphatic acids, especially vinyl acetate, copolymers of vinyl chloride with esters of acrylic and methacrylic acid and with acrylonitrile, copolymers of vinyl chloride with diene compounds and unsaturated dicarboxylic acids or their anhydrides, such as copolymers of vinyl chloride with diethyl maleate, diethyl fumarate or maleic anhydride, post-chlorinated polymers and copolymers of vinyl chloride, copolymers of vinyl chloride and vinylidene chloride with unsaturated aldehydes, ketones and others, such as acrolein, crotonaldehyde, vinyl methyl ketone, vinyl methyl ether, vinyl isobutyl ether and the like; polymers of vinylidene chloride and its copolymers with vinyl chloride and other polymerizable compounds; polymers of vinyl chloroacetate and dichlorodivinyl ether; chlorinated polymers of vinyl carboxylate, such as vinyl acetate, vinyl propionate, vinyl butyrate, chlorinated polymeric esters of acrylic acid and of alpha-substituted acrylic acid, such as methacrylic acid, of nitriles, amides, alkyl esters such as acrylonitrile, (meth)acrylamide, methyl (meth)acrylate, butyl acrylate, ethyl acrylate, 2-ethyl hexyl acrylate; polymers of vinyl aromatic derivatives, such as styrene, dichlorostyrene; chlorinated rubbers; chlorinated polymers of olefin, such as ethylene, propene, 1-butene, (2.2.1)bicyclo heptene-2, (2.2.1) bicyclo hepta-diene-2,5; polymers and post-chlorinated polymers of

chlorobutadiene and copolymers thereof with vinyl chloride, chlorinated natural and synthetic rubbers, and also mixtures of these polymers with one another or with other polymerizable compounds. In the context of this invention, PVC also embraces copolymers with polymerizable compounds such as acrylonitrile, vinyl acetate or
5 ABS, which can be suspension, bulk or emulsion polymers. Preference is given to PVC homopolymers and copolymers, optionally post-chlorinated, alone or in combination with polyacrylates. Also included are graft polymers of PVC with EVA, ABS and MBS. Preferred substrates are also mixtures of the abovementioned homo- and copolymers, especially vinyl chloride homopolymers, with other thermoplastic
10 and/or elastomeric polymers, especially blends with ABS, MBS, NBR, SAN, EVA, CPE, MBAS, PMA, PMMA, EPDM and polyactones.

These polymers can be thermoplastic and/or elastomeric.

Examples of such components are compositions of (i) 20-80 parts by weight of a vinyl chloride homopolymer (PVC) and (ii) 80-20 parts by weight of at least one
15 thermoplastic copolymer based on styrene and acrylonitrile, in particular from the group ABS, NBR, NAR, SAN and EVA. The abbreviations used for the copolymers are familiar to the person skilled in the art and have the following meanings: ABS: acrylonitrile-butadiene-styrene; SAN: styrene-acrylonitrile; NBR: acrylonitrile-butadiene; NAR: acrylonitrile-acrylate; EVA: ethylene-vinyl acetate. Also suitable in
20 particular are acrylate-based styrene-acrylonitrile copolymers (ASA). Preferred components in this context are polymer compositions comprising as components (i) and (ii) a mixture of 25-75% by weight PVC and 75-25% by weight of the abovementioned copolymers. Examples of such compositions are: 24-50% by weight PVC and 75-50% by weight copolymers of 40-75% by weight PVC and 60-25% by
25 weight copolymers. Preferred copolymers are ABS, SAN and modified EVA, especially ABS, NBR, NAR and EVA are also particularly suitable. In the composition of the invention it is possible for one or more of the abovementioned copolymers to be present. Particularly important components are compositions comprising (i) 100 parts by weight of PVC and (ii) 0-300 parts by weight of ABS and/or SAN-modified
30 ABS and 0-80 parts by weight of the copolymers NBR, NAR and/or EVA, but especially EVA.

For stabilization in the context of this invention, further suitable polymers are, in particular, recyclates of chlorine-containing polymers, these polymers being the polymers described in more detail above that have also undergone damage through

processing, use or storage. PVC recyclate is particularly preferred. The recyclates may also include small amounts of extraneous substances, such as, for example, paper, pigments, adhesives, which are often difficult to remove. These extraneous substances may also arise from contact with various materials in the course of use or reprocessing, examples being residues of fuel, fractions of coating material, traces of metal and residues of initiator.

Stabilization in accordance with the invention is of particular advantage in the context of PVC formulations which are customary for pipes and profiles. Stabilization can be effected without heavy metal compounds (Sn, Pb, Cd, Zn stabilizers). This characteristic offers advantages in certain fields, since heavy metals -with the exception of zinc at best- are often unwanted both during the production and during the use of certain PVC articles, on ecological grounds. The production of heavy metal stabilizers also often causes problems from an industrial hygiene standpoint. Similarly, the processing of ores containing heavy metals is frequently associated with serious effects on the environment, the environment here including the biosystem of humankind, animals (fish), plants, the air and soil. For these reasons, the incineration and landfilling of plastics containing heavy metals is also disputed.

In order to achieve stabilization in the chlorine-containing polymers or resins, the compound(s) of the Formula I are preferably to be used in a proportion of judiciously from about 0.01 to about 10% by weight, preferably from about 0.05 to about 5% by weight and, in particular, from about 0.1 to about 3% by weight of the total stabilized polymer or resin.

The stabilising composition of the invention can judiciously be incorporated by the following methods: as an emulsion or dispersion (one possibility, for example, is the form of a pastelike mixture. An advantage of the combination of the invention in the case of this form is the stability of the paste); as a dry mix in the course of the mixing of additional stabilisers and/or polymer mixtures; by direct addition to the processing apparatus (e.g. calenders, mixers, compounders, extruders and the like), or as a solution or melt or as flakes or pellets in dust-free form as a one-pack product.

The PVC stabilized in accordance with the invention can be prepared in a manner known per se using devices known per se such as the abovementioned processing apparatus to mix the stabilising composition of the invention and any

further additives with the PVC. In this case, the stabilizers can be added individually or as a mixture or else in the form of so-called masterbatches.

The PVC stabilized in accordance with the present invention can be brought into the desired form by known methods. Examples of such methods are milling, calendaring, extruding, injection molding or spinning, and also extrusion blow molding. The stabilized PVC can also be processed to foam materials.

A PVC stabilized in accordance with the invention is suitable, for example, for hollow articles (bottles), packaging films (thermoform sheets), blown films, pipes, foam materials, heavy profiles (window frames), transparent-wall profiles, construction profiles, sidings, fittings, office films and apparatus enclosures (computers, domestic appliances).

Preference is given to PVC rigid foam articles and PVC pipes for drinking water or wastewater, pressure pipes, gas pipes, cable-duct and cable protection pipes, pipes for industrial pipelines, seepage pipes, flowoff pipes, guttering pipes and drainage pipes. For further details on this subject see "Kunststoffhandbuch PVC", Vol. 2/2, W. Becker/H. Braun, 2nd ed., 1985, Carl Hanser Verlag, Pages 1236-1277.

Examples

In the following examples the term « phr » means per hundred of PVC resin (ex : 0,2 phr : 0,2 g per 100 g of PVC).

Example 1

Two PVC formulations are evaluated using a Collin two-rollmill, the rolls of which are brought to 190 °C. The rotational speeds of the 2 cylinders are respectively adjusted to 20 rpm and 24 rpm, so as to gel and squeeze the material between the cylinders while contributing frictional work. The separation between the cylinders is adjusted to 0.5 mm. Samples are withdrawn from the cylinders at regular time intervals, their coloration being recorded.

The components of the 2 PVC formulations and their amounts (in phr) are the following:

PVC (Lacovyl S110P, Atofina, kW = 68) :	100
Paraffin wax (Licolub XL 165, Clariant)	0.5
PE wax (Licolub PE 520, Clariant)	0.7
oxidized PE wax (A-C 316A, Honeywell)	0.05
calcium carbonate (Omyalite 90T, Omya)	10
TiO ₂ (CL 2220, Kronos)	1

calcium stearate (Stavinor CAPSE, Atofina) 0.7
 Na zeolite P (Wessalith P, Degussa) 0.3
 Stabiliser of the hydrazide -type 0.2 or 0 (PVC

formulations of Table I)

5 Stabiliser of the hydrazide -type 1 or 0 (PVC

formulations of Table II)

Stab 1 = benzoic hydrazide (CAS n° 613-94-5)

Stab 2 = salicylic hydrazide (CAS n° 936-02-7)

Stab 3 = hydrazide of thiophene-2 carboxylic acid (CAS n° 2361-27-5)

10 Stab 4 = adipic hydrazide (CAS n° 1071-93-8)

Stab 5 = isophthalic hydrazide (CAS n° 2780-98-7)

Stab 6 = stearic hydrazide (CAS n° 4130-54-5)

Stab 7 = maleic hydrazide (cyclic) (CAS n° 123-33-1)

Stab 8 = Fumaric hydrazide (CAS n° 3538-81-6)

15 Stab 9 = dibenzoic-1,2 hydrazide (CAS n° 787-84-8)

Stab 10 = 2-Phenyl acetic hydrazide (CAS n° 937-39-3)

Stab 11 = Carbohydrazide (CAS n° 497-18-7)

The Yellowing Index (YI, ASTM Standard E 313) is measured on each sample withdrawn and the results are reported in Table I or II below:

20

Table I

t (min)	without hydrazide compound	Stab 1	Stab 2	Stab 3	Stab 4	Stab 5	Stab 7	Stab 8	Stab 9	Stab 10	Stab 11
2	25.3	18.6	22.8	20.4	13.7	19.2	16.8	15.7	23	17.3	14.5
3	36.2	22.6	25.7	25.2	14.8	20.7	22.6	21	29	21.7	21.5
4	39.5	27.5	28.3	28.7	16.8	22.2	31.6	31	35	28.5	44.3
5	43.4	32.7	30.8	33	19.1	23.4	39	41	42	33.4	50
6		38.1	33.8	37.3	24.6	24.7	46.5		50	46.6	
7		44.5	36.6	43.3	29.6	26.1	52		56	49.7	
8		50.5	39.3	48.6	38.1	29.1	58			51.8	
9		56.3	43	54.1	50.1	34.2	62			52.4	
10		57.3	46.6	57.8		41.1	66			53.5	
12			54.7			46.4				55.7	

Table II

t (min.)	without hydrazide compound	Stab 1	Stab 2	Stab 3	Stab 4	Stab 5	Stab 6	Stab 7	Stab 8	Stab 9	Stab 10	Stab 11
2	25.3	15.9	23.6	18.7	18.8	21	15.3	17.2	17	26	13.2	13.6
3	36.2	16.2	23.2	19.4	16.7	22	18.4	15.6	27	30	14.1	18.7
4	39.5	18.1	24.3	20.9	17.4	23	21.8	14.4	38	36	15.4	34.8
5	43.4	19.5	25.9	23.1	19.6	24	27.2	14.1	48	43	17.3	59.5
6		21.6	27.5	26	24.8	25	34			50	20.4	
7		25.1	28.7	29.5	28.5	26	45				24.7	
8		29.8	30.3	34.8	50	26.5	52				31.2	
9		36.2	31.3	41	63	27.5	57				38.9	
10		44	32.6	50		29					43.9	
12		48.2	35.8			31					52.5	
15			44.2			37.5						
18			52									

The results listed in both Tables I and II show the efficiency of the stabilisation effect of the compositions of the present invention not only on the initial color of the PVC formulation but also on the long term colorhold retention compared to unstabilized formulation.

Example 2

A combination of hydrazides may result in combining benefits of individual components as demonstrated in Table III (results of yellow index as measured on samples submitted to heat and shear on two roll mill type as described in example 1 and at 190°C, 20-24 rpm).

Table III

PVC (Lacovyl S110P)	100	100	100	100	100
Paraffin wax (Licolub XL 165)	0.5	0.5	0.5	0.5	0.5
PE wax (Licolub PE 520)	0.7	0.7	0.7	0.7	0.7
Oxidized PE wax (AC-316)	0.05	0.05	0.05	0.05	0.05
Calcium Carbonate (Omyalite 90T, Omya)	10	10	10	10	10
TiO ₂ (CL 2220)	1	1	1	1	1
Calcium Stearate (Stavinor CAPSE)	0.7	0.7	0.7	0.7	0.7
Adipic hydrazide	0.5				
Isophthalic hydrazide		0.5	0.2		0.3
Stearic hydrazide			0.3		
2-Phenyl acetic hydrazide				0.5	0.2

Yellow Index at t (min.)					
2 min.	13.7	18.1	16.6	13	15
3 min.	14.1	19.5	17.6	14.6	16.6
4 min.	14.7	20.8	18.6	16.3	17.7
5 min.	16.2	21.7	19.6	17.4	18.7
6 min.	17.5	22.6	20	20.1	19.5
7 min.	20.6	23.4	20.8	23.2	20.6
8 min.	24.7	24.3	23.3	27	21.1
9 min.	31.4	25.1	25	31.8	22.2
10 min.	41.4	26.1	30.1	37.9	23
12 min.	44	27.8	46.6	48.8	25.8
15 min.		32.7			36.7

Example 3

The dynamic thermal stability of 3 PVC formulations have been measured according to the same protocol as disclosed in Example 1 (at 190°C, 20-24 rpm) The components of the 3 PVC formulations and the results of the evaluation are presented in Table IV below:

Table IV

PVC (Lacovyl S110P)	100	100	100
Paraffin wax (Licolub XL 165)	0.8	0.8	0.8
Oxidized PE wax (A-C 629A)	0.15	0.15	0.15
Calcium stearate (Stavinor CAPSE)	0.5	0.5	0.5
Na zeolite P (Wessalith P)	0.3	0.3	0.3
adipic hydrazide	1	-	1
zinc stearate (Stavinor ZnE, Atofina)	-	0.2	0.2
Yellow Index			
2 min.	13.7	61.4	14
3 min.	16.5	80	15.7
4 min.	18.3	90.7	18.9
5 min.	24.1	96.3	22.7
6 min.	33.8	98.8	28.2
7 min.	61.3	99	35.4
8 min.	111	98.4	57.4

It can be shown that the presence of zinc carboxylate improves the color of the PVC formulation: a synergistic effect is shown between zinc carboxylate and the stabilising composition of the invention.

5 Example 4

The dynamic thermal stability of 3 PVC formulations have been measured according to the same protocol as disclosed in Example 1 (at 190°C, 20-24 rpm). The components of the 3 PVC formulations and the results of the evaluation are presented in Table V below:

Table V

PVC (Lacovyl S110P)	100	100	100	100
Paraffin wax (Licolub XL 165)	0.8	0.8	0.5	0.5
oxidized PE wax (A-C 629A)	0.15	0.15	0.05	0.05
PE wax (Licolub PE 520)			0.7	0.7
calcium stearate (Stavinor CAPSE)	0.5	0.5	0.7	0.7
Na zeolite P (Wessalith P)	0.3	0.3	0.3	0.3
chalk (Omyalite 90 T, Omya)			10	10
TiO ₂ (CL 2220)			1	1
isophthalic hydrazide	-	1	-	1
Yellow Index				
2 min.	25.3	19		21
3 min.	36.2	21.8		22
4 min.	39.5	23.6		23
5 min.	43.4	25		24
6 min.		26.7		25
7 min.		27.9		26
8 min.		29.7		26.5
9 min.		30.2		27.5
10 min.		32.1		29
12 min.		35.2		31
15 min.		43		37.5

It can be shown that a judicious choice of other additives (such as lubricants, calcium stearate, pigments,...) is required to optimize the performances of the stabilizer composition of the present invention.

Exemple 5

Tables VI and VII illustrate the role of costabilizers added to the hydrazide based system. The test protocol followed is the same as explained in example 1 (190°C, 20-24 rpm).

Table VI

PVC (Lacovyl S110P)	100	100	100	100	100	100	100	100	100
Paraffin wax (Licolub XL 165)	0.8	0.8	0.5	0.5	0.8	0.8	0.8	0.8	0.8
oxidized PE wax (A-C 629A , Honeywell)	0.15	0.15	0.05	0.05	0.15	0.15	0.15	0.15	0.15
Calcium stearate (Stavinor CAPSE)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Adipic hydrazide	1	/	1	1	1	1	/	1	1
Trimethylol propane (TMP, Perstorp)		0.7	0.7						
Dimethyl-1,3 aminouracil 6 (CAS n° , Aldrich)				0.2					
Diphenylisodecyl phosphite (Stavinor DPIDP, Atofina)						0.3			
Alcamizer IV-2 (Kyowa)							0.5	0.5	
Zinc stearate (Stavinor ZnE)									0.2
Na zeolite P (Wessalith P)					0.3				
Yellow Index									
2 min.	13.7	33	10.9	17.6	13.5	11.5	41.7	15.2	14
3 min.	16.5	54.4	12.2	19.4	14.74	13.5	63.8	16.3	15.74
4 min.	18.3	77.4	14.3	22	17.6	19.2	70.8	20	18.9
5 min.	24.1	96.1	17.5	27.2	20	23.7		24.2	22.7
6 min.	33.8	107	21.8	35	24.3	44.6		27.9	28.2
7 min.	61.3	110	29.7	46.9	29.7	73		32.8	35.4
8 min.	111	115	51.1	72.4	42.1	124		37.9	57.3
9 min.		119	88.7	103	70.5			44.6	103.5
10 min.		123	118		108			55.8	

Table VII

PVC (Lacovyl S110P)	100	100	100	100	100	100	100	100
Paraffin wax (Licolub XL 165)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
oxidized PE wax (A-C 629A)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
PE wax (Licolub PE 520)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Calcium stearate (Stavinor CAPSE)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Na zeolite P (Wessalith P)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Calcium carbonate (Omyalite 90 T)	10	10	10	10	10	10	10	10
TiO ₂ (CL 2220)	1	1	1	1	1	1	1	1
Stearic hydrazide						0.5	0.5	
Adipic hydrazide	1		1		1			1
Dihydropyridine (Stavinor D507, Atofina)		0.2	0.2					
Perchlorate component (MP100, Akishima)				0.5	0.5		0.5	
Zinc stearate (Stavinor ZnE)								0.2
2 min.	13.8	29.5	13.4	19.5	13.3	17.5		14
3 min.	14.5	41.7	13.9	27.3	13.8	20.8	20.6	15.7
4 min.	16	51.7	15.5	30.2	14.6	24.8	24	18.9
5 min.	19.2	59.4	18.4	34.2	15.8	28.6	27	22.7
6 min.	24.7	63.1	23.4	37.4	16.9	34.4	29.8	28.2
7 min.	36.6		33.0	40	18.5	38.2	32.7	35.4
8 min.	54.8		48.3	42.5	19.7	43.4	34.2	57.3
9 min.	64.5			44.2	21.7	52.4	36	103
10 min.				45.1	23.3	54.9	37.3	
12 min.				46.4	23		40	
15 min.					37.8		44.5	
20 min.							50.2	

Example 6

The effect of increasing the concentration of hydrazide is shown on table VIII

- 5 (the system is hydrazide-zeolite). As in the examples above the test is done on a two roll mill at 190°C, 20-24 rpm.

Table VIII

PVC (Lacovyl S110P)	100	100	100	100	100	100	100	100
Paraffin wax (Licolub XL 165)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
oxidized PE wax (A-C 629A)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
PE wax (Licolub PE 520)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Calcium stearate (Stavinor CAPSE)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Calcium carbonate (Omyalite 90 T)	10	10	10	10	10	10	10	10
TiO ₂ (CL 2220)	1	1	1	1	1	1	1	1
Na zeolite P (Wessalith P)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Adipic hydrazide	0.2	0.5						
Isophthalic hydrazide							0.2	2
Stearic hydrazide			0.2	2				
2-Phenyl acetic hydrazide					0.2	2		
Yellow Index								
2 min.	13.7	13.3		14.9	16.3	13.7	16.1	17.3
3 min.	14.8	14.4	27.3	16.4	20.1	14.2	18.3	20
4 min.	16.8	15.5	33.9	18.3	24.6	14.7	19.8	20.5
5 min.	19.1	17	40.5	20.5	28.6	15.9	20.5	22
6 min.	24	19.9	46.4	24.1	36.5	17.8	22.1	22.9
7 min.	29.6	25.4	51.1	29.3	38.7	20.4	23.5	23.5
8 min.	38.6	33.9	53.7	34.7	44.4	23.9	24.7	24.6
9 min.	50.1	47.7	51.8	41.5	49.5	27.1	27.5	25.4
10 min.				48.7	52.7	31.2	31.9	26.3
				57.7	49.7	47.6	45.7	28.1
								30.6

Example 8

- 5 5 PVC formulations for pipe extrusion whose components are listed in the following Table IX are processed on a single screw extruder Polylab Rheomex 252P from Haaake (ϕ 19 mm, L/D 25). The temperature profile set up was: 195-200-195°C with a screw speed of 40 rpm (bulk temperature at the entrance of the die: 188°C).

Table IX

Formulation n°	1	2	3	4	5
PVC (Lacovyl S110P)	100	100	100	100	100
Paraffin wax (Licolub XL 165)	0,5	0,5	0,5	0,5	0,5
Oxidized PE wax (A-C 629A)	0,05	0,05	0,05	0,05	0,05
PE wax (Licolub PE 520)	0,7	0,7	0,7	0,7	0,7
calcium stearate (Stavinor CAPSE)	0,7	0,7	0,7	0,7	0,7
Na zeolite P (Wessalith P)	0,3	0,3	0,3	0,3	0,3
chalk (Omyalite 90 T)	10	10	10	10	10
TiO ₂ (Kronos 2220)	1	1	1	1	1
Organic based system from the market based on dimethyl 1,3 aminouracil-6	1				
benzoic hydrazide		1			
adipic hydrazide			1		
thiophene-2 carboxylic acid hydrazide				1	
isophthalic hydrazide					1
Yellow Index (...min)	18.1	10.0	15.6	16.2	17.2

The stabilizer of the present invention allows to achieve a surface aspect
 5 and color of the extrudate very satisfying compared to already existing organic based
 systems.